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Socio-Economic Determinants Of Adoption Of Recommended Rice Technologies Among Smallholder Farmers In Ebonyi State, Nigeria

Nwakpu, C. C.
Department Of Agricultural Economics, Management And Extension, Ebonyi State University, Abakaliki, Nigeria.

Abstract
The study examined the socio-economic determinants of adoption of recommended rice technologies among smallholder farmers in Ebonyi State of Nigeria. A multistage random sampling procedure was employed to select a total of 144 respondents comprising 72 adopters and 72 non-adopters of the recommended technologies on whom structured questionnaire were administered for the purpose of this study. Descriptive statistics and Inferential statistics involving Probit analysis were used for data analysis. The result showed that majority (52%) of the adopters fell within the middle age category of 31 – 40 years whereas the greatest percentage (40%) of the non-adopters fell within the older age limits of 51 years and above with a mean age of 40 years for adopters and 53 years for the non-adopters. The study also showed that whereas majority (60%) of the non-adopters were illiterates who received no formal education, only 15% of adopters were illiterates. The result of the Probit regression analysis revealed that age, level of formal education, farm size, level of income, access to credits and membership to farmers' cooperatives or groups greatly influenced the smallholder farmers' decision to adopt or not to adopt the recommended rice technologies in the area at 5% level of significance. The study also showed that constraints to the adoption of recommended rice technologies in the area include, high cost and scarcity of improved certified rice seeds, high cost of agrochemicals, high level of illiteracy, poor and weak extension system among others. Policy measures aimed at the provision of effective and practical oriented agricultural extension education to famers in all the major rice producing communities across the country as well as Rice institutions collaboratively designing and implementing rice out-growers scheme to help overcome the problem of scarcity and high cost of improved rice seeds among others were recommended towards massive adoption of improved rice technologies and attainment of self sufficiency in domestic rice production in Nigeria.

Keywords: *Adoption, determinants, rice technologies, Nigeria.*

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I. Introduction

With increasing number of population growth crisis in most developing countries especially Nigeria, the production of those crop commodities that have heightened demand as major staple forms key imperative in efforts to achieve food self sufficiency and attain sustainable economic growth and development (Eboh et al, 2009). Among such crop commodities, rice (*Graminae oryzae*) which apart from wheat is currently the most important cereal crop in the world clearly stands out (Chang and Luh, 1990). Nwakpu (2016) stated that the growing importance of rice in Nigeria's food economy has resulted to the astronomical increase in both aggregate and per capita consumption of the staple in the country. The author further added that its domestic production has consequently grossly fallen short of consumption demand, thus necessitating the Federal Government of Nigeria (FGN) having to spend the whopping sum of over ₦365 billion Naira annually on rice importation. This is economically unsustainable and various institutions therefore recommended several technological innovations to solve the problems of poor yield, pests and diseases, water logging, infertile soil, nutrient management, drought etc to boost rice production in Nigeria. (NCRI, 1994, IITA 1988, IRRI, 1985). These technologies which include use of improved high yielding and resistant rice varieties, early planting, use of herbicides, use of pesticides, establishment and maintenance of bonds and drainage channels, off season planting and sheath harvesting have been pushed to farmers. Yet, annual rice production has for the past decades continued to decline or fluctuate in Nigeria (Nwakpu 2022, PCU 2007, Nwakpu 2003, Singh 1997). Omotayo *et al*. (2001) and Akpokodje *et al*. (2001) argued that the above scenario is attributable to the fact the adoption of these technologies by the smallholder farmers who constitute about 90% of the nation's farming population is very low.

Idrisa (2012) defined technology adoption as the decision to make full use of a new idea as the best course of action available and involves a change in the orientation and behavior of the farmer, while Ndaghu et al (2015) listed factors including age, farming experience, training received, socio-economic status of farmers, source of information etc with emphasis on the prominent importance of the socio-economic characteristics of famers as having been found to have positive and significant association to adoption of recommended technologies by farmers. Although Mellor (1985) observed that application of agricultural technologies has much to do with economies of scale, Ladebo (1999) maintained that smallholder farmers are most willing to adopt recommended technologies in so far as such technologies are profitably affordable especially with respect to the socio-economic potentials of the farmers. Besides, Dingkhum and Randolph (1997) argued that socio-economic factors and farmers' potential to manage resources under emerging technologies change over time and space. With these conflicts in focus, this study was conducted to help document empirically the socio-economic determinants of adoption of recommended rice technologies among smallholder farmers in Ebonyi State of Nigeria. Specifically, the study described the socio-economic characteristics of farmers in the study area, identified and analyzed the socio-economic factors which influenced farmers' decision to adopt or not to adopt the recommended rice technologies in the area, identified major constraints to the adoption of improved rice technologies in the area and advanced recommendations based on findings.

II. Methodology

Study Area

The study was conducted in Ebonyi State of Southeast Nigeria. Its selection for the study was based on the fact that Ebonyi is a major food producing area in Nigeria and rice represents the key agricultural enterprise for farmers in the State. (Echiegu, 2002).

Ebonyi State which was created out of the former Abia and Enugu States on 1st October 1996 geographically lies between latitudes 7º30' N and 8º30' N and longitudes 5º40'E and 8º45' E .The State has a landmass of 5,935Km^2 most of which are arable and fertile for agricultural production (Egwu, 2002). According to National Population Census (NPC) of 2006, Ebonyi State has a current population projection of about 3.4 million people. Apart from the fact that over 15% of the total land area in the State belong to the lowland ecology greatly suited to lowland rice production, there is a concentration of rice milling machines in the State and with Abakaliki Rice Mills Industries, Ebonyi is reputed to be having the highest concentration of rice mills in the of whole West African Sub-region (Nwambe, 2004, Egwu 2002).

Echiegu (2002) maintained that over 80% of the State's population are engaged in agriculture growing different types of food and cash crops including rice, yam, cassava, cocoyam, maize, etc as well as keeping of some small ruminants and rearing of cattle. Ebonyi is made up of thirteen Local Government Areas and divided by the Ebonyi State Agricultural Development Programme (EBADEP) into three agricultural zones; Ebonyi North Zone, Ebonyi Central Zone and Ebonyi South Zone.

Sampling and Data Collection

Six local Government Areas; two from each of the three Agricultural Zones of the State were purposively selected for this study. These were Abakaliki and Izzi LGAs (from Ebonyi North Zone), Ikwo and Ezza South (from Ebonyi Central Zone) Afikpo South and Ivo LGAs (from Ebonyi South Zone).

Employing multistage sampling procedure, a total of 144 smallholder rice farmers (comprising 72 adopters and 72 non-adopters) of the recommended rice technologies for both lowland and upland rice systems respectively were selected on whom structured questionnaire were administered for the study during the 2022 cropping season.

In determining who was an adopter and non-adopter, the researcher defined a rice farmer who practiced at least fire out of the seven components of the technology package as an adopter. On the other hand, the rice farmer who did not practice the recommended but used the traditional or unimproved rice production practices was considered a non-adopter.

Method of Data Analysis

Descriptive statistics such as mean, averages, percentage, etc were used to analyze the socio-economic characteristics of the respondents. Inferential statistics involving Sequential Probit regression analysis was used to analyze the socio-economic factors that determined farmers' decision to adopt or not to adopt the recommended rice technologies. Descriptive statistics were also used to achieve the last objective on constraints to the adoption of recommended technologies.

Model Specification

The Sequential Probit model used in achieving the second objective reflected the two adoption categories of the selected technologies as estimated below:

si = 1 if i becomes an adopter
si = 0 if i does not adopt

The possibilities are:
$P(si=1) = F(b_I \times i)$---------- (1)
$P(si=0) = I\{I-f(b_I xi)\}\{F(b_2 xi)\}$ (Maddala, 1983)---------- (2)

where:
F = Standard normal distribution function
b_1 and b_2 = model parameters
The generalized model for the study was therefore explicitly stated as follows.
$Y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 + \ldots\ldots\ldots\ldots\ldots\ldots + \beta_n x_n + \mu$ ---------- (3)

Where:-
Y = Adoption decision (Decision to adopt =1, decision not to adopt = 0)
β_0= constant
β_1 to β_n = coefficients of independent variables
μ = stochastic or error term
(The independent variables specified as determinants of adoption are defined as follows)
X_1 = AGE = Age (in years)
X_2 = SEX = Sex (dummy 1 for male; 0 for female).
X_3 = FEXP = farming experience (in years)
X_4 = FEDU = Level of formal education (in years)
X_5 = HHSZ = Household size (in number of persons)
X_6 = NPFW = Number of persons participating in farm work(in numbers)
X_7 = FMSZ = Farm size (in hectares)
X_8 = INCM = Level of income (in Naira)
X_9 = ACRDT = Access to credit (in Naira)
X_{10} = MFGC = Membership to farmers' group or co-operatives (dummy 1 for membership; 0 otherwise)

III. Results And Discussion

Socio-Economic Characteristics of Respondents

The socio-economic characteristics of the respondents; viz adopters and non-adopters of the recommended rice technologies were presented in Table 1.

Table 1. Socio-Economic Characteristics of Respondents

		Adopters			Non-Adopters		
Variable	Description	Freq. 72	% age	(Mean)	Freq 72	%age	(Mean)
Age	30 yrs and below	9	13		6	8	
	31 – 40	38	52		17	24	
	41 – 50	23	32	(40yrs)	20	28	(53yrs)
	51 – 60	2	3		24	33	
	Above 60	-	-		5	7	
Sex	Male	64	89		60	83	
	Female	8	11		12	17	
	Total	72	100		72	100	
Marital status	Single	2	3		2	3	
	Married	63	87		59	82	
	Divorced	5	7		6	8	
	Widower	2	3		5	7	
Educational level	No formal education	15	21		43	60	
	Primary	31	43		24	33	
	Secondary	21	29		5	7	
	Tertiary	5	7		0	0	
Farming experience	Below 10yrs	8	11		7	10	
	10 – 19yrs	32	45	(16yrs)	20	28	(30yrs)
	20yrs and above	32	44		45	62	
Household size	<5	6	8		4	5	
	5 – 8	37	52		20	28	
	9 – 12	18	25	(7psns)	23	32	(12psns)

	>12	11	15		25	35	
Farm size cultivated	<1ha	4	6		14	19	
	1 – 3ha	48	67	(2.7ha)	52	72	(1.8ha)
	>3ha	20	27		6	9	
Annual income	<₦400,000	4	5		25	35	
	₦400,000 to ₦600,000	30	42	(₦720,000)	34	46	(₦490,000)
	>₦600,000	38	53		13	19	
Access to credit	Received credit	34	47		10	14	
	Received no credit	38	53		62	86	
Membership of farmers' co-op soc. and other social orgzns.	Farmers' co-op.	50	69		10	14	
	Other soc. Orgns	68	94		16	22	
	Village org	70	97		65	90	
	No membership	-	-		7	10	

The values with asterisks (*) indicates multiple responses
Source: Field Survey 2014/2015.

The result shows that whereas the greatest percentage (52%) of the adopters fell within the middle age of between 31 and 40 years, the greatest (40%) of the non-adopters fell within the older age bracket of 51 years and above with mean age of 40 years for the adopters and 53 years for the non-adopters. These results were not unexpected because middle age and younger farmers are known to be more receptive to new innovations and can take risks more than older farmers (Babaji et al 2019, Eze 1997,). The results also show high percentage of 89% and 83% of the adopters and non-adopters respectively were males whereas 11% and 17% of the adopters and non-adopters respectively were females. This low percentages of females on both categories confirm earlier findings by Okorji and Obiechina (1985) that whereas males involve themselves more in the production of cash and food crop commodities, females grow more of domestic or vegetable crops. This also has unpleasant implication should more farmers in the area decide to stick to old traditional methods which require a lot of females provided labour in weeding and manual threshing operations. With respect to formal education, the result shows that whereas 60% of the non-adopters had no formal education, 79% of the adopters received formal education. This is in conformity with the earlier findings by Onyenweaku and Nwaru (2005) that education positively affected farmers production efficiency and their decision to adopt improved agricultural technologies in Imo State. The result also showing that 62% of the non-adopters had farming experience of 20 years and above with average farming experience of 30 years is indicative of the fact that though most of the aged farmers were averse to risk and did not adopt the technological package, they had joined subsistence traditional farming early in life. The results also show that whereas the adopters had average household size of 7 persons, the non-adopters had average household size of 12 persons. The results also show that the adopters had mean farm size of 2.7 hectares while the non adopters had mean farm size 1.8 hectares. This implies that the adopters who have larger farm sizes than the non-adopters are deemed to be wealthier and more likely to afford the cost of adopting the recommended rice technologies. These findings are consistent with earlier findings by Ayele (1999) that farm size positively influenced the adoption of vertisol technology by smallholder farmers in Ethiopia. With annual mean income of ₦720,000 for the adopters and ₦490,000 for the non-adopters the results also show that whereas 35% of the non-adopters fell within the low annual income (LI) category of less than ₦400,000 per annum, only 5% of the adopters fell within this low income (LI) category. However, majority of the rice farmers on both categories in the area were relatively well off falling above low income category of less than ₦400,000 per annum. This confirms earlier assertion by Echiegu (2002) that rice production is a key economic enterprise of farmers in Ebonyi State. The result also shows that whereas only 47% and 14% of the adopters and non-adopters respectively received credit facilities, 53% and 86% of the adopters and non-adopters respectively received no credit facilities. Table 1 also shows that whereas 69% and 94% of the adopters belonged to farmers' co-operatives and other social organizations respectively, only 14% and 22% of the non-adopters belonged to farmers' co-operatives and other social organizations respectively. These results were in agreement with the earlier findings by Eze (1997) that in Nsukka Agricultural Zone of Enugu State of Nigeria, membership of co-operatives and social organizations enhanced farmers' adoption of improved fishing technologies.

Socio-economic Variables Influencing Adoption Decision of the Respondents.

The adoption decision of farmers was analyzed using the Probit model as presented in Tables 2 and 3 for lowland and upland rice farmers respectively.

Table 2 Probit Model Result for the Lowland Rice Farmers.

Variables	Variable code	Estimated coefficient	Elasticity Result	Asymptotic t-values
Age	AGE	-0.08756	-0.2919	(-2.48)**
Sex	SEX	0.9074	0.0702	(1.36)
Farming Experience	FEXP	-0.00941	0.0109	(-0.18)
Formal Education	FEDU	0.1848	0.1654	(2.82)**
Household Size	HHSZ	-0.0071	-0.0224	(-0.11)
No of persons in HH participating in farm work	NPFW	0.1544	0.0289	(1.28)
Farm size	FMSZ	0.1983	0.3581	(2.89)**
Income	INCM	0.1758	0.2703	(2.32)**
Access to Credit	ACRDT	2.5226	0.3376	(2.93)**
Membership to farmers groups or co-operatives	MFGC	0.1971	0.0158	(1.24)
Pseudo R^2 (Nagelkerke) Chi-square		(0.683) 29.916		

Note: The values with asterisks indicate that they are significant at 5% level.
Source: Field Survey 2022

The results from the Probit model as presented in Table 2, shows that out of the ten independent variables analyzed, those found to be significantly related to the adoption decision (dependent variable) of the lowland rice farmers are; age, level of formal education, farm size, income and access to credit. Farm size has the highest positive significant impact on their adoption decision since it has the highest elasticity value of 0.3581 and t value of (2.89)** at 5% level of significance. Age has negative sign indicative of the fact that as age increases, the lowland rice farmers' decision to adopt the recommended technologies decreases. This finding is in agreement with earlier studies which show that younger people are more risk friendly and adopt new technologies more than older ones who are more averse to risks. For instance, Awolowo et al (2019) found that the adopters of improved cassava varieties in Ogun State were of younger age matrix than the non-adopters.

The result also indicates that out of the three Psedo R^2 of Cox and Snell; Nagelkerke and McFadden; Nagelkerke's was chosen as the lead coefficient of determination (R^2). This is because it has the highest value that is greater than the level of determination (P>0.05). The overall significance of the Probit model was depicted by the Chi-Square which was significant at 5% level of significance indicative of the fact that the regression result was statistically reliable.

Table 3. Probit Model Result for the Upland Rice Farmers.

Variables	Variable Code	Estimated Coefficient	Elasticity Result	Asymptotic t-values
Age	AGE	-0.0753	-0.3853	(-2.42)**
Sex	SEX	0.2778	0.0345	(0.31)
Farming Experience	FEXP	0.02750	0.0036	(1.41)
Formal Education	FEDU	0.1645	0.5752	(2.42)**
Household size	HHSZ	-0.0562	-0.0028	(-0.93)
No of persons In HH participating in farm work	NPFW	0.1230	0.0566	(0.61)
Farm size	FMSZ	0.9003	0.6742	(2.37)**
Income	INCM	0.8735	0.7893	(2.8)**
Access to Credit	ACRDT	-0.6716	-0.2687	(-0.59)
Membership to Famers Groups or Co-Operatives	MFGC	0.8592	0.3932	(2.81)**
Pseudo R^2(Nagelkerke) Chi-Square		(0.613) 29.825		

Note: The values in asterisks are significant at 5% level.
Source: Field Survey 2022

For the upland rice farmers, the results from the Probit model as presented in Table 3 shows that out of the ten independent variables analyzed, those found to be significantly related to the adoption decision (dependent variable) of the upland rice farmers in the area are; age, level of formal education, farm size, income level and membership of farmers' co-operatives or groups. With the highest elasticity value of 0.7893 and t-value of (2.85)** at 5% level of significance, income level has the highest positive impact on adoption decision among the upland rice farmers in the area.

The results also indicate that Nagelkerke's R-square was chosen out of the three Pseudo R-squares of Cox and Snell, Nagelkerke and Mcfadden as the lead coefficient of determination (R^2). This is because it has

the highest value that is greater than the level of probability (P>0.05). Again, the overall significance of the Probit model as depicted by the Chi-Square which was significant at 5% level show that the regression result was statistically reliable. The findings are in agreement with earlier reports by Onyenweaku and Nwaru (2005) that several socio-economic characteristics of farmers such as age, level of formal education, farming experiences, income level, farm size etc significantly affected smallholder farmers' decision to adopt or not to adopt technological innovations.

Major Constraints to the Adoption of Recommended Rice Technologies

This section looked that the major constraints of improved rice technologies. These constraints were high cost and scarcity of improved certified rice seed varieties, lack of agrochemicals and spraying machines**,** high cost of agrochemicals and sprayers**,** technological packages unaffordable, high level of illiteracy among farmers, and poor or weak extension system. Results of the analysis is presented in Table 4.

Table 4: Major Constraint to the Adoption of Improved Rice Technologies.

Major constraint	Freq = 144	%	Rank
High cost and scarcity of improved certified rice seed varieties	47	33%	1st
Lack of agrochemicals and spraying machines	10	7	6th
High cost of Agrochemicals and Sprayers	36	25	2nd
Technological packages unaffordable	12	8	5th
High level of illiteracy among farmers	24	17	3rd
Poor or weak extension system	15	10	4th

Source: field Survey: 2022

Results from Table 4, shows that with 33% of the respondents, high cost and scarcity of improved certified rice seed varieties ranked first as the major constraint to the adoption of the recommended rice technologies in the area. The recommended improved rice seed varieties that were scarce and costly include FARO 44, FARO 52, AND FARO 57 for the lowland rice system and FARO 46(ITA 150) and FARO 55 (Nerica 1) for the upland rice system. This was followed by 25% of the respondents for high cost of agrochemicals, fertilizers, pesticides, herbicides especially selective rice herbicide and sprayers; 17% for high level of illiteracy among the farmers and 10% for poor or weak extension system being ranked as 2nd, 3rd, and 4th constraints respectively to the adoption of recommended rice technologies in the area.

IV. Conclusion And Recommendations

The study revealed that whereas the adopters had mean age of 40 years and the non-adopters had mean age of 53 years, with majority (60%) of the non-adopters being illiterates. The result of the Probit model revealed that age, level of formal education, farm size, income level, access to credit and membership to farmers co-operatives or groups were significantly related to both lowland and upland rice farmers' decision to adopt or not to adopt the recommended rice technologies in the area. High cost and scarcity of improved certified rice seeds, high cost of agrochemicals, high level of illiteracy among others were found as major constraints to the adoption of recommended rice technologies in the area. The study therefore, recommended for policy measures aimed at the provision of effective and practical oriented agricultural extension education to farmers, collaborative design and implementation of rice out-growers scheme by relevant rice Institutions involving at least 300 rice farmers from each of the major rice growing states in the country as well as policy measures to increase and expand agric finance credit portfolios to enable farmers have easier access to the funds required to procure the needed inputs for the adoption of recommended technologies for increased yield and profitable rice farming in Nigeria.

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